ENERGY HARVESTING USING OCEAN DATA ACQUISITION SYSTEM (ODAS) BUOY FOR CORAL REEF MONITORING

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DEDICATION

This study is wholeheartedly dedicated to my parents, who have been the source of inspiration and gave the strength in time of difficulty, who continually provide their moral, spiritual, emotional and financial support. They taught me that even the largest task can be accomplished if it is done one step at a time.

Last but not least I dedicate this study to Allah my creator, the Ever-Magnificent, the Ever-Thankful, for giving me the strength, knowledge, ability and opportunity to undertake this study and to preserve and complete it satisfactorily. Without His blessing, this achievement would not have been possible.

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ABSTRACT

The threat to coral reefs in the ocean and coastal areas is growing, the main thing that threatens coral reefs is weather changes and human activities. If this is not in concern it will damage the coral reef which is the habitat of most marine life. There are several methods to monitor the coral reef status, one of the methods is by using Ocean Data Acquisition System (ODAS) Buoys. Generally, the buoy is a system that used to monitor and collect data for oceanographic and meteorological research purposes. The long-term environmental anomalies study will have required lots of energy due to the usage of sensors and devices. The potential energy of solar and wind to generate electricity for use to extend the life of the buoy used for the duration of the monitoring possible for a day, a week, or a year without having to come to change the existing energy supply on the buoy. Hence the solar wind hybrid system is analyse using Matlab to see how far the solar wind hybrid can produce the energy. Solar irradiation weather data and wind speed taken from NASA POWER database for different locations such as Pulau Perhentian, Pulau Besar, Labuan Island and Sandakan coastline. After that the result acquired were compared to the calculated data. The result of the calculation indicates that Labuan Island and Sandakan coast produces high energy ranging from 400W to 700W which can accommodate the amount of burden demanded. While the results obtained from the simulation shows that the energy produced is far different from the energy generated by the equation calculation. This matter may be caused by several factors that exist in the simulation parameter, this cause by the non-matching with the equation used and the wind speed in the location recoded is not strong enough to move the wind turbine.

ABSTRAK

Ancaman terhadap terumbu karang di kawasan lautan dan pesisir semakin meningkat, perkara utama yang mengancam terumbu karang adalah perubahan cuaca dan aktiviti manusia. Jika ini tidak dibendung, ia akan merosakkan terumbu karang yang merupakan habitat kehidupan marin yang paling utama. Terdapat beberapa kaedah untuk memantau status terumbu karang, salah satu kaedahnya adalah dengan menggunakan buoys Ocean Data Acquisition System (ODAS). Secara umum, pelampung adalah sistem yang digunakan untuk memantau dan mengumpul data untuk tujuan penyelidikan oseanografi dan meteorologi. Kajian jangka panjang akan memerlukan banyak tenaga kerana penggunaan sensor dan peranti. Tenaga yang berpotensi seperti solar dan angin menghasilkan tenaga elektrik untuk digunakan dapat memanjangkan umur pelampung yang digunakan untuk tempoh pemantauan yang mungkin untuk satu hari, seminggu, atau setahun tanpa perlu mengubah bekalan tenaga sedia ada pada pelampung . Oleh itu, sistem hibrid angin solar menganalisis menggunakan Matlab untuk melihat sejauh mana hibrid angin solar boleh menghasilkan tenaga. Data cuaca penyinaran solar dan kelajuan angin diambil dari pangkalan data NASA POWER di pelbagai lokasi seperti Pulau Perhentian, Pulau Besar, Pulau Labuan dan pantai Sandakan. Selepas itu keputusan diperoleh dibandingkan dengan data yang dikira. Hasil perhitungan menunjukkan bahawa Pulau Labuan dan Pantai Sandakan menghasilkan tenaga yang tinggi dari 400W hingga 700W yang dapat menampung jumlah beban yang diminta. Walaupun keputusan yang diperoleh dari simulasi menunjukkan bahawa tenaga yang dihasilkan jauh berbeza dengan tenaga yang dihasilkan oleh pengiraan persamaan. Perkara ini mungkin disebabkan oleh beberapa faktor yang wujud dalam parameter simulasi, sebab ini dengan tidak sepadan dengan persamaan yang digunakan dan kelajuan angin di lokasi yang direkodkan tidak cukup kuat untuk menggerakkan turbin angin.

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LIST OF SYMBOLS AND ABBREVIATIONS

A - Area swept
AC - Alternating Current
C - Weibull scale parameter
C - Capacity of the battery
Cg - Group velocity
Cp - Power coefficient DC - Direct Current

DOD - Dept of discharge
Ek - kinetic energy

Ep - potential energy

F(v) - Distribution function

F_{pv} - Derating factor

G - Solar
irradiation GA -
Genetic
algorithm g -

Acceleration due to gravity

H - wave height I -

Ampere

Io - Cell temperature

I_t - Global solar irradiation incident

K - kilo

k - Dimensionless Weibull shape parameter

L - Load

L - wave length P -

Air density ρ - mass density of

water PV - Photovoltaic

P_{pv} - Energy output
Pw - power output from the wind turbine

R - Resistance

T - period of wave

Γ - Gamma function V - Voltage

v - Speed of wind

W - Watt

Y_{pv} - Rated capacity σ - Standard deviation

AUV -Autonomous Underwater Vehicle

BBDB -Backward bent duct buoy

CTI-CFF -Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security

HAWT -Horizontal-Axis of Wind Turbine
LPSP - Loss of power supply probability

NASA -National Aeronautics and Space Administration

OBS -Oscillating body system

OWC -Oscillating Water Column

ODAS -Ocean Data Acquisition System
POWER -Prediction of Worldwide Energy Resources

THDv -Total harmonic ratio

TNB -Tenaga Nasional Berhad

VAWT -Vertical Axis of Wind Turbine

CHAPTER 1

INTRODUCTION

1.1 Project overview

The ocean is one of the most important sources of human resources, as the source of the ocean is the source of food supply. The ocean is also home to various species of marine life, especially coral reefs which are the most important source of life in the ocean. The coral reefs are a place or residence for ocean creatures other than that they supply food and oxygen to the fish in the vicinity. Therefore, it is important to ensure that the food cycle for humans and the life of the sea is well preserved. According to [1], recent coral reefs face critical threats that may be caused by global climate change, therefore periodic monitoring of coral reefs should be carried out. It is crucial so that we can see the changes that occur on the coral reefs and be able to perform the measures such as ecological processes, growth and bio erosion rates, reproduction and recruitment and hydrodynamics. There several methods used to monitor the coral reef status which are belt transects, long swims, basic monitoring module, surface and underwater vehicles and buoy. One way to continuously monitor ocean data is by using Scientific Buoys known as Ocean Data Acquisition System (ODAS) Buoys.

The buoy is a system that were used to monitor and to collect data from oceanographic and meteorological in the ocean and coastal areas specifically in the coral reef environment for research purposes. The long-term environmental anomalies study will have required lots of energy due to the usage of sensors and devices. Usually, the ODAS buoy is powered by batteries. Among the enormous potential energy available in the ocean are solar energy, wind energy and wave energy produced by the sea itself. The potential energy of solar and wind to generate electricity for use to extend the life of the buoy used for the duration of the monitoring possible for a day, a week, or a year without having to come to change the existing energy supply on the buoy [2]. In this study, solar and wind energy is selected to generate electricity to the buoy known as the Ocean Data Acquisition System (ODAS) buoy. To ensure that adequate and continuous energy supply for the functionality of the equipment, a hybrid natural energy harvesting method is proposed.

There are many tools used in the ODAS including range of sensors, some of which are used to monitor and receive data from the sea and equipment used to transmit information to land stations. ODAS usually uses the source of electricity from existing available power batteries, and ODAS battery at charging using the solar panels during the day. During the monsoon season the solar irradiation is not enough to charge the existing battery, therefore, other alternatives need to be developed to ensure that the supply on the battery is always sufficient to use.

1.2 Problem statement

Coral reef life is important to ensure that the food spans of the sea can be maintained and rescued from the devastating consequences of climate change and human threats. For the ODAS buoy used for monitoring coral reefs, it is equipped with a variety of sensors requiring a lot of electrical energy to operate for a long time. The buoyant ODAS is located in the middle of the ocean far from the existing energy supply. The main problem faced by buoy ODAS is the limited power supply system via battery. The battery needs to be changed every time it runs out of energy and it takes a lot of time and energy to go to switch the battery on the ODAS buoy in the middle of the ocean. To ensure that continuous electricity supply can be supplied to ODAS then an initiative should be made to find ways to extend the energy supply life of the ODAS to long-term.

1.3 Objectives

The main objectives to this project this to develop an energy harvesting using Ocean Data Acquisition System (ODAS) buoy of coral reef monitoring. The sub-objective is:

i. To formulate a suitable energy harvesting method for coral reef environment ii. To design energy harvesting system for Ocean Data Acquisition System

(ODAS) buoy iii. To compare the performance of proposed energy harvesting system by using calculation and simulation.

1.4 Project scopes

The focus of this project primarily to develop an energy harvesting using Ocean Data Acquisition System (ODAS) buoy of coral reef monitoring. Thereby, to achieve the project objectives, several limitations in certain aspect knows as scopes for this project is being pointed out. The focused research scopes are as follows.

i. ODAS

   The platform uses to ocean data acquisition system to monitor the coral reef area in Malaysia.

ii. Solar panel

   The photovoltaic panel use to harvest the solar irradiation to convert into electricity.

iii. Wind turbine

   The Wind Sensor use to harvest kinetic wind energy to transform into mechanical energy then convert into electrical energy.

1.5 Thesis organisation

Overall, this thesis is being composed with five chapter and is organisation as follows. Chapter one brief about the overall introduction to cover the project background that lead to the problem statements and provide the objective solution and the scope for this project and the significances of this project. The chapter two will highlighted the literature review on harvesting energy using Ocean Data Acquisition System (ODAS) buoy of coral reef monitoring, thought solar photovoltaic (PV), wind energy, and wave energy for harvesting energy at the Malaysia offshore. The chapter three describes the method used to develop a three-phase harvesting energy using ODAS to develop this system. while chapter four will show the results obtained through the developed system using two different methods using the equation calculations and using the simulation. Finally, chapter five discusses the results obtained and provides suggestions for improvements for future research.is the method

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Harvesting natural energy is becoming a major concern, in the past 20 years the global energy demand has increased up to 45% all over the world. Most likely all the energy is produced from a carbon emission such as fossil fuel that has a negative effect in our world. To mitigate the effects of global warming on Earth, long-term use of renewable energy such as solar energy, wind power, hydropower should be used to replace carbon combustion in the future [3], [4]. In additional, serious increased in environmental pollution and energy crisis has become far worse than ever and caused the negative impact in our daily life [5], [6]. The renewable energy is very important even in remote areas or areas far away from the existing sources of modern energy [7]. With 70% of the earth is covered by the ocean water, solar, wind and waves energy has become the potential renewable energy source to be explored [8]. However, such many of ocean energy is still under-exploited due to high cost, low efficiency and most likely the difficulties of the engineering structure [3]. There are several types of techniques for harvesting energy form ocean through solar, wind and waves. All of these techniques have great potential to be applied to harvesting energy from the ocean. The rest of this chapter is dedicated for reviewing the potential energy harvesting from ocean by using

Ocean Data Acquisition System (ODAS) to supply the energy need to the ODAS itself. The main problem faced by buoy ODAS is the limited power supply system that the battery supplied before, the battery needs to be changed every time it runs out of energy and it takes a lot of time and energy to go to switch the battery on the ODAS buoy in the middle of the ocean. For that, a continuous power supply system should be designed especially the renewable system available at the buoy site, among which the system can be designed is like a solar panel system and wind turbine as the buoy is in the middle of the ocean it receives full light from the sun at during the day and it also receives the wind and waves that continues without any obstacles [9]. There are three main sources available which are the Photovoltaic Solar energy, wind energy, and wave energy.

2.2 Harvesting Renewable Energy

Renewable energy is very important for everyday life where dependence on energy generated through carbon combustion that has a long-term impact on this world. The term energy harvesting is an electronic device capable of maintaining energy by applying natural energy around for current use [10] .There are a variety of techniques that can be used for energy harvesting, such as energy from suns that emit solar energy, strong winds blowing in the sea and land area and the strength of water flowing from man-made dam. According to the report issued by the United State government in 2009 energy harvesting supplies little energy for the use of small electronic equipment energy consumption compared to the large-scale energy generation using many sources such as oil, coal and other.

2.3 Coral Reef

The southern China Sea is the place where most biodiversity is at a distance of 3 million km^2, comprising six Southeast Asia countries such as Malaysia Indonesia Philippine and others. Coral triangle is the most abundant place of sea life that depends on it. In 2007 coral triangle initiative on coral reefs, fisheries, and food security (CTICFF) was established to collaborate with six countries namely Indonesia,

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